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# Volume 23, Tower-Perturbation Measurements in Above-Water Radiometry

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# Chapter 4

## Advances in Data Processing Methods

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Abstract

New versions of the data processing methods were created to accommodate a) the incorporation of an automated system for determining the ratio of diffuse-to-direct solar irradiance, and b) the correction for bidirectional effects in the above-water (sea-viewing) measurements. The former required a more sophisticated correction to the occulted solar reference data, and the latter required a more complete formulation of the above-water method. Neither advancement altered the type of data collected or the basic data collection methodology.

## 4.1 INTRODUCTION

The primary advances in data processing during the time period covered by the tower-perturbation campaigns were a consequence of a) replacing the manual occulting of the global solar irradiance with an automated capability (a variant of SeaSHADE), and b) including a more complete correction for bidirectional effects in the above-water (sea-viewing) measurements.

## 4.2 THE IRRADIANCE RATIO

Estimating the magnitude of perturbations in underwater optical measurements from instrument self-shading and large deployment structures (ships and towers) requires information on the sky radiance distribution. The computation of sky radiance requires an accurate knowledge of atmospheric optical parameters (i.e., the scattering phase function and optical thickness) and the use of exact radiative transfer codes. Computations for cloudy conditions, however, may be affected by large uncertainties. Because of this, operational correction schemes for the removal of self-shading and platform perturbations were proposed by parameterizing the effects of sky radiance distribution with the diffuse-to-direct downward irradiance ratio $r_d(\lambda)$ (Gordon and Ding 1992 and Doyle and Zibordi 2002).

The determination of $r_d(\lambda)$ is possible using irradiance sensors by collecting the total $E_d(0^+,\lambda)$ and the diffuse $E_i(0^+,\lambda)$ downward irradiance. In most cases, $E_i(0^+,\lambda)$ measurements are acquired by shading the direct sun irradiance component with an occulter (usually a wand-shaped device resembling a lollipop) manually placed at some distance from the collector(s) of the radiometer such that the shadow from the occulter completely shades the diffuser(s).

The difficulty with manually occulting solar references is the sensors are frequently placed in difficult access locations on many ships, so data collection is usually not convenient and in many circumstances hazardous (even with a safety harness). An alternative to the manual solar occulter is provided by radiometers equipped with rotating shadow bands autonomously occulting the global (direct plus diffuse) sun irradiance (Guzzi et al. 1985 and Harrison et al. 1994).

Based on an automated occulting principle, SeaSHADE was developed to autonomously measure $E_i(0^+,\lambda)$ with the same radiometer used for measuring $E_d(0^+,\lambda)$ during the collection of in-water optical profiles of $E_d(z,\lambda)$, $E_u(z,\lambda)$, and $L_u(z,\lambda)$ (Hooker and Lazin 2000). The SeaSHADE occulting element is a hemispherical band moving at a constant speed over the top of the irradiance sensor and blocking a portion of the sky with approximately a 7° angle.